Distillation Troubleshooting

Henry Z. Kister

Fluor Corporation

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To my son, Abraham and my wife, Susana, who have been my love, inspiration, and the lighthouses illuminating my path,

and to my life-long mentor, Dr. Walter Stupin – it is easy to rise when carried on the shoulders of giants.

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DISTILLATION TROUBLESHOOTING DATABASE OF PUBLISHED CASE HISTORIES

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Preface

"To every problem, there's always an easy solution—neat, plausible, and wrong."

—Mencken's Maxim

The last half-century has seen tremendous progress in distillation technology. The introduction of high-speed computers revolutionized the design, control, and operation of distillation towers. Invention and innovation in tower internals enhanced tower capacity and efficiency beyond previously conceived limits. Gamma scans and laser-guided pyrometers have provided troubleshooters with tools of which, not-so-long-ago, they would only dream. With all these advances, one would expect the failure rate in distillation towers to be on the decline, maybe heading towards extinction as we enter the 21st century. Our recent survey of distillation failures (255) brought disappointing news: Distillation failures are not on the path to extinction. Instead, the tower failure rate is on the rise and accelerating.

Our survey further showed that the rise is not because distillation is moving into new, unchartered frontiers. By far, the bulk of the failures have been repetitions of previous ones. In some cases, the literature describes 10–20 repetitions of the same failure. And for every case that is reported, there are tens, maybe hundreds, that are not.

In the late 1980s, I increased tray hole areas in one distillation tower in an attempt to gain capacity. Due to vapor cross flow channeling, a mechanism unknown at the time, the debottleneck went sour and we lost 5% capacity. Half a year of extensive troubleshooting, gamma scans, and tests taught us what went wrong and how to regain the lost capacity. We published extensively on the phenomenon and how to avoid. A decade later, I returned to investigate why another debottleneck (this time by others) went sour at the same unit. The tower I previously struggled with was replaced by a larger one, but the next tower in the sequence (almost the same hydraulics as the first) was debottlenecked... by increasing tray hole areas!

It dawned on me how short a memory the process industries have. People move on, the lessons get forgotten, and the same mistakes are repeated. It took only one decade to forget. Indeed, people moved on: only one person (beside me) that experienced the 1980s debottleneck was involved in the 1990s efforts. This person actually questioned

the debottleneck proposal, but was overruled by those who did not believe it will happen again.

Likewise, many experiences are repeatedly reported in the literature. Over the last two decades, there has been about one published case history per year of a tower flooding prematurely due to liquid level rising above the reboiler return nozzle, or of a kettle reboiler bottleneck due to an incorrectly compiled force balance. One would think that had we learned from the first case, all the repetitions could have been avoided. And again, for every case that is reported, there are tens, maybe hundreds that are not.

Why are we failing to learn from past lessons? Mergers and cost-cuts have retired many of the experienced troubleshooters and thinly spread the others. The literature offers little to bridge the experience gap. In the era of information explosion, databases, and computerized searches, finding the appropriate information in due time has become like finding a needle in an evergrowing haystack. To locate a useful reference, one needs to click away a huge volume of wayward leads. Further, cost-cutting measures led to library closures and to curtailed circulation and availability of some prime sources of information, such as, AIChE meeting papers.

The purpose of this book is pick the needles out of the haystack. The book collects lessons from past experiences and puts them in the hands of troubleshooters in a usable form. The book is made up of two parts: the first is a collection of "war stories," with the detailed problems and solutions. The second part is a database mega-table which presents summaries of all the "war stories" I managed to find in the literature. The summaries include some key distillation-related morals. For each of these, the literature reference is described fully, so readers can seek more details. Many of the case histories could be described under more than one heading, so extensive cross references have been included.

If an incident that happened in your plant is described, you may notice that some details could have changed. Sometimes, this was done to make it more difficult for people to tell where the incident occurred. At other times, this was done to simplify the story without affecting the key lessons. Sometimes, the incident was written up several years after it occurred, and memories of some details faded away. Sometimes, and this is the most likely reason, the case history did not happen in your plant at all. Another plant had a similar incident.

The case histories and lessons drawn are described to the best of my and the contributors' knowledge and in good faith, but do not always correctly reflect the problems and solutions. Many times I thought I knew the answer, possibly even solved the problem, only to be humbled by new light or another experience later. The experiences and lessons in the book are not meant to be followed blindly. They are meant to be taken as stories told in good faith, and to the best of knowledge and understanding of the author or contributor. We welcome any comments that either affirm or challenge our perception and understanding.

If you picked the book, you expressed interest in learning from past experiences. This learning is an essential major step along the path traveled by a good troubleshooter or designer. Should you select this path, be prepared for many sleepless nights in the plant, endless worries as to whether you have the right answer, tests that will

shatter your favorite theories, and many humbling experiences. Yet, you will share the glory when your fix or design solves a problem where others failed. You will enjoy harnessing the forces of nature into a beneficial purpose. Last but not least, you will experience the electric excitement of the "moments of insight," when all the facts you have been struggling with for months suddenly fall together into a simple explanation. I hope this book helps to get you there.

HENRY Z. KISTER

March 2006

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H.Z.K.